EODIS Core System (ECS)
Critical Design Review Assessment Strategy

WHITE PAPER (revised[1] copy)

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PREPARED BY :

EOSDIS IV&V TEAM

outline **page**

[1] *text italics* indication changes between June 30 and July 27, 1995.

Section 1 Background

The Earth Sciences Data and Information Systems (ESDIS) Project Office, NASA GSFC Code 505, has responsibility for the development of the Earth Observing System (EOS) Data and Information System (EODIS).

This paper defines an EODIS CORE SYSTEM (ECS) **Critical Design Review** (**CDR**) **Assessment** process to be performed by IV&V (ref. Exhibit 1-1). The assessment goal is to determine if the Critical Design phase specifications are complete enough to lower continued ECS Release development risk to an acceptable level.

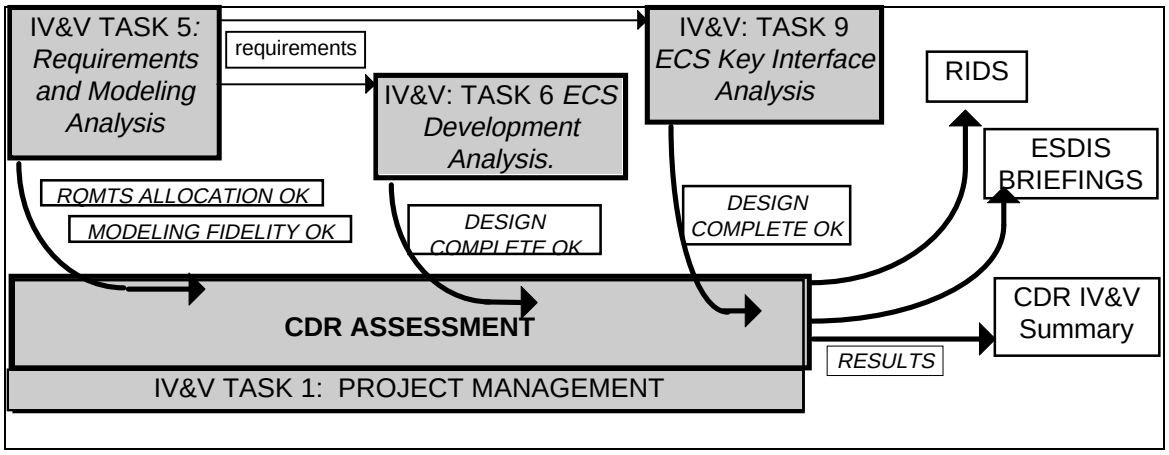

EXHIBIT 1-1. CDR Assessment & IV&V Task relationships (block diagram)

1.1 Purpose This white paper presents the **IV&V ECS CDR Assessment** strategy.

1.2 Scope This paper includes a high level summary of the objectives, expected results, and plan. Detailed definitions of the methods, evaluation criteria, and resource estimates are contained in a separate detailed IV&V internal planning document.

1.3 Document Organization This paper is organized into several major sections.:

Section 1: Background	• CDR Assessment context • paper scope and organization
Section 2: ...Process	• Executive Summary -- objectives & approach
Section 3: ....Expected Results	explains what the assessment will produce
Section 4: ....Recommendations for Use	possible ways to apply assessment information
Section 5: ....Implementation Plan	high level assessment project schedule
Appendix A: CDR Success Criteria cross-reference	shows where each the ESDIS CDR Success Criteria"M. Banks list" items are covered in the assessment process; also lists other criteria sources
Appendix B: Contact List	individuals outside of the IV&V Team who provided insight in defining the CDR Assessment approach
Appendix C: Document Sources	documents used as reference materials

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Section 2 ECS CDR Assessment Process

EXECUTIVE SUMMARY

The ECS CDR Assessment approach is aimed at a meaningful risk assessment as opposed to a mechanical review. While the primary target is to assess system design completeness, there are three factors which considered together determine risk -- Product, Systems Engineering, and Programmatics.

ECS Assessment Objectives cross-referenced to CDR Assessment Processes

Category	CDR Assessment Objectives	CDR ASSESSMENT process which meets objective
Product:	• evaluate design completion • determine if *design* meets architecture constraints • determine the extent to which design addresses requirements	I-A. Verify Contract Deliverable Requirement List (CDRLs) I-B. Verify PDR *Open Item*[2] Completion
Systems Engineering:	• evaluate whether HAIS has implemented planned systems engineering controls and methods to reduce technical risk	II-A. Verify Risk Assessment List *incorporated* II-B. Verify COTR specified Systems Engineering criteria II-C. Verify Planned Multi-track Development Implementation *per SEP, SIP, SDP* II-D. Verify Planned OMT Model Of Evolving Requirements
Programmatics:	• evaluate whether HAIS has implemented planned project controls and resources to ensure product quality and reduce cost and schedule risk.	III-A. Verify ECS Model Fidelity III-B. Verify technical product schedule meets end-to-end test as scheduled III-C. Correlate Contractor Software Quality Assurance metrics *to IV&V metrics* III-D. Verify contractor specified Object Transition Plan in place

There are also secondary objectives to add value without inflicting undue cost or burden on HAIS, and to be realistic given schedule and resource constraints.

[2] Targeted for completion of CDR, *including RIDs dipositioned*

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SUMMARY OF THE CDR ASSESSMENT PROCESSES

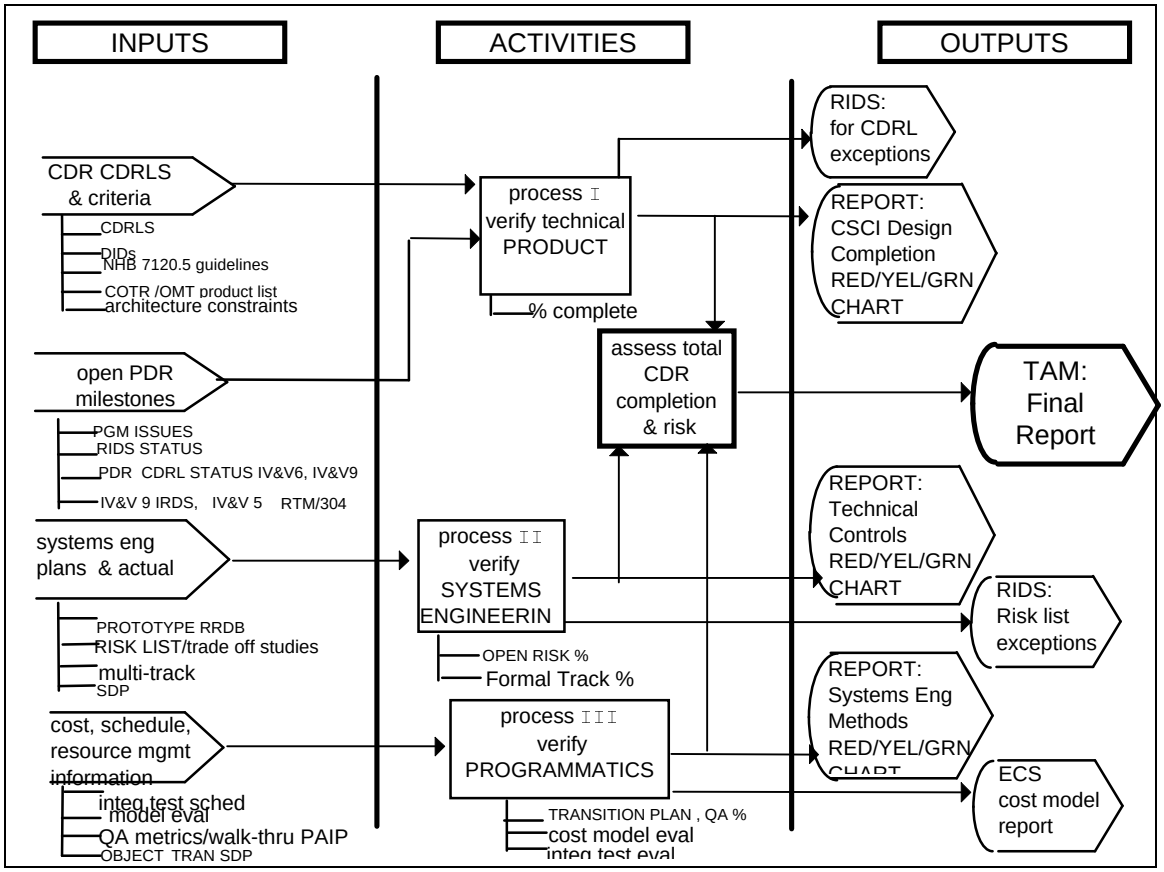

EXHIBIT 2-1. CDR ASSESSMENT Activity Network

A benefit of this approach is that it recognizes overlap between the design products and methods.[3] If only CDR CDRLs are reviewed in an assessment, there are two problems. One is that the review may not be sufficient; the evolutionary multi-track and object methodology products are not explicitly addressed in existing standards. A problem on the opposite side is that if the assessment narrowly looks at CDRLs, there is a danger of exaggerating the development risk because contractor risk abatement isn't considered.

Process I: Verify Technical PRODUCT is the largest assessment effort. It verifies that the CDR CDRLS exist, meet requirements, and are complete. It verifies that the System, CSCI and component designs meet architecture constraints. It also verifies that PDR milestones are complete: object, dynamic, and functional models for each CSCI and critical component.

Process II: Verify SYSTEMS ENGINEERING evaluates Risk Assessment List closure via trade-off studies and prototyping, and whether development plans are used as published. It determines that "multi-track" does not by-pass methodology safety gates by assigning a majority of the design to the Informal Track in response to CDR schedule demands.

Process III: Verify PROGRAMMATICS assesses the ECS model fidelity, Release input to the program end-to-end test schedule, and HAIS *plans for* QA *per PAIP*, and Object (skills) Transition plan *per SDP*.

[3] *reference* NASA Management of Major System Programs and Projects, NHB 7120.5.

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Section 3 ECS CDR Assessment Expected Results

The final output of the CDR Assessment is a Technical Analysis Memorandum which consolidates the results of the three CDR Assessment processes:

I Verify PRODUCT,
II Verify SYSTEMS ENGINEERING, and
III Verify PROGRAMMATICS.

In addition, active CDR support will include two preliminary, and daily CDR briefings from each of the assessment processes in accordance with the CDR Agenda. The briefing reports will be in the form of "Fever" (Red, Yellow, Green condition) charts. The charts will be produced prior to the CDR meetings when the required input is available to do so.

The criteria used to evaluate the inputs to each process is detailed in a separate CDR Assessment "how to" Planning Document. Numeric scoring, percent complete calculations, and *objective factors are used.*

Exceptions found in the CDRL verification will be used to initiate RID recommendations using ESDIS procedures. Fever charts will correspond to Proposed RIDS: red to class 1, yellow to class 2. The CDR TAM shall be reviewed by ESDIS prior to publication.

EXAMPLES:

PRODUCT "FEVER CHART"

SYSTEM/CSCI	VERIFY CDRLS	VERIFY PDR MILESTONES COMPLETE
RELEASE A: TRMM		
CSCI 1:.....		
Subsystem 1: **.....**		
CSCI 2:		

SYSTEMS ENGINEERING "FEVER CHART" **PROGRAMMATICS "FEVER CHART"**

PROJECT CONTROL	RED	YEL	GRN	N/A
Model Fidelity				
End-to-End Test Schedule				
Object Transition plan				
SQA Correlation				

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PLANNED METHOD	RED	YEL	GRN	N/A
Risk List Closure				
ESDIS Sys. Eng. Criteria				
Multi-Track				
OMT Evolving Rqmt Capture				

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Section 4 ECS CDR Assessment Recommendations for use

The following are the recommended actions based on the process "fever" charts, RIDs, and the Final CDR Assessment TAM.

Category	CDR ASSESSMENT process	Recommendation
Product:	I-A. Verify Contract Deliverable Requirement List (CDRLs)	IF all CDRL items are not delivered, THEN CDR is incomplete and a RID is issued for each exception If the systems level design is complete and 70% or > of the 17 CSCIs are condition green, and If all critical detailed design units (estimated 100 of 300) are condition green, Then code and test proceeds for the 70%+ and is held for the remainder until complete Else code and test stops until 70% and all critical design units are complete and/or contractor converts to traditional *functional type CDR inspection*
	I-B. Verify PDR *Open Items*	*The PDR open items completion will be evaluated in the same manner as the CDR items above.*
Systems Engineering:	II-A. Verify Risk Assess List *Incorp*	IF all risk assessment list items are not closed, THEN CDR is incomplete and a RID is generated for each exception
	II-B. Verify COTR specified Systems Engineering criteria II-C. Verify Multi-Track Development Implementation II-D. Verify Plan OMT Model Evolving Requirements	IF condition green, contractor gets credit for systems engineering quality /risk reduction If condition yellow, no credit is given. (Progress to be evaluated quarterly, AND if the trend is equal to 25% improvement per quarter, THEN contractor gets credit at next CDR/IDR.) If plan is condition red, corrective action: **1.** contractor resubmits plans within 30 days, or **2.** *traditional systems engineering doc required*
Program-matics:	III-A. Verify ECS Model Fidelity III-D. Verify Object Transition Plan in place	IF condition green, contractor gets resource quality/risk credit IF condition yellow, no credit is given. (Progress to be evaluated quarterly, AND if the trend is equal to 25% improvement per quarter, THEN contractor gets credit at next CDR/IDR.) IF condition red, corrective action: resubmits plans within 30 days
	III-B. Verify product meets end-to-end test schedule	IF exceptions exist, THEN CDR is incomplete and a RID is generated for each exception
	III-C. Correlate Contractor Software QA metrics	If IV&V and HAIS QA critical (100 units) metrics correlation is within 15%, (green) then credit HAIS risk control, Else sample 200 non-critical units before code/ corrective action

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Section 5 ECS CDR Assessment Implementation Plan

CDR Assessment Deliverables are planned as follows:

Preliminary Meetings:

Aug. 3rd:	Fever charts for CDRLS/DIDs which can be reviewed prior to CDR
Aug. 10th:	Fever charts for CDRLS/DIDs which can be reviewed prior to CDR

CDR Briefings:

Aug 14 -18:	Daily 30 minute pre-cdr review of fever charts for items on CDR agenda

Post CDR:

Aug 21-25:	preliminary TAM and RID review discussions with SMO
Aug 25:	*working TAM draft to ESDIS, and preliminary RIDs to ESDIS RID advocate*
Aug 31:	final TAM and RIDs

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APPENDIX A: CDR Success Criteria Cross Reference

CDR ASSESSMENT PROCESS	ESDIS ECS CDR Success Criteria	OTHER Criteria Source
PRODUCT I-A. **Verify Contract Deliverable Requirement List (CDRLs)** CDRL checklist and review per DIDs 305/DV2 (F) Segment/Design Specification detailed review for system, CSCI, and critical components *calculate percent complete based on CDRL delivered documents and OMT/NASA NHB 7120.5*	• baseline diagrams complete at subroutine/class/CSC level • Completion of Design Specification (key deliverable document) sufficient to allow the system to be coded PDL for all non-trivial operations for each class PDL (or equivalent) for each subroutine/class/CSC PDL follows C++ syntax with class definitions, member functions and comments description of architecture including hardware and software segment level event traces for key segment scenarios for each subsystem: updated context diagram which shows all interfaces with other subsystems and external entities modification to preliminary context diagram which reflects detailed interface definition process • All interfaces (internal and external) completely satisfied interface definition include source, destination, classes, data structures, nominal frequency, and description • major design changes since PDR • Data base definition and schema specification physical representation of data base schema to be implemented in support of subsystem operations	EOSDIS Core System Contract Data Requirements Document, Revision A, 423-41-03, NAS5-6000, Attachment D, June 2, 1994 Management of Major System Programs and Projects HANDBOOK, NASA NHB 7120.5, Nov. 8, 1995 James Rumbaugh, et al, Object Oriented Modeling and Design, Prentice-Hall International, Inc., c 1991 ECS Ground System Architecture Description Document and ESDIS SMO Architect *Defining Architectural Development of EOSDIS to Facilitate Extension to a Wider Data Info System, 194-00131, April, 1994*
calculate percent complete for system, csci, and critical components to support fever chart rating and final TAM	Metrics associated with CDR: 1. Component designs completion measurement/percentages, plan vs. Actual 2. test procedures, plan vs. Actual 3. costs selections (numbers of) plan vs actual 4. approved PO's, plan vs actual 5. software developed, planned SLOC vs. Actual SLOC month 6. scheduled key events (e.g. workshops, prototype/early sw deliveries) completion measurement plan vs. Actual 7. *SMO criteria for ICDs, 0% missed I/F, 25% TBD, 50+% TBC/S, 100% complete icd*	
I-B. **Verify PDR Milestones Complete** updated open CDRL and RID status from IV&V 6 updated Object,	• baseline diagrams complete at subroutine/class/CSC level • Completion of Design Specification (key deliverable document) Object Models, detailed dynamic models, functional models) Detailed Dynamic models include set of scenarios and event trace diagrams that represent boundary, and erroneous processing conditions, as well as	EOSDIS Core System Contract Data Requirements Document, Revision A, 423-41-03, NAS5-6000, Attachment D, June 2, 1994 Management of Major

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Dynamic, and Functional model review from IV&V6 updated requirements allocation status from IV&V5 determine percent complete for system release A, CSCI, and critical unit to back up fever chart and final TAM	nominal conditions state diagrams for non-trivial interface classses to identify additional attributes, operations, and associations necessary for the interface state diagrams to define complex interactions between classes detailed functional models which contain descriptions and data flow diagrams of all complex operations within object model Performance description text for requirements applicable to a particular subsystem and approach to fulfilling reqmts data dictionary of each class and associated attributes and operations level 4 requirements trace to class and to operations within class if applies • All interfaces (internal and external) completely satisfied • map implementation to required functions (will an implementation of this design provide all required functions) • defined set of required documents -use criteria for review/measurement of quality (e.g. completeness, correctness (meets objectives, requirement, intended audience), clarity and well-structured, conciseness, consistency with overall design, congruency with schedule (delivered on time) • major design changes since PDR • changes to system ops since PDR (updated scenarios and system performance considerations) • changes to major SW components since PDR with justifications • issues/risks/problems (e.g. review of TBDs, RIDs since PDR)	System Programs and Projects HANDBOOK, NASA NHB 7120.5, Nov. 8, 1995 James Rumbaugh, et al, Object Oriented Modeling and Design, Prentice-Hall International, Inc., c 1991 IV&V Task 5 Requirements Analysis & Traceability results IV&V Task 6 ECS Development Analysis TAMs IV&V Task 9 Interface Analysis results ECS Monthly Review RID status and issue lists PDR RIDs GAO Testimony on EOS, March, 1995 Prototyping and Studies Plan for the ECS Project, May 1994, HAIS, CDRL item 052, 194-317-MG1-001 *Software Development Plan for the ECS Project,DEC 1994, HAIS, 308-CD-001-003* *revised 7/95*
verify completion from open lists and calculate percent complete as described above	• Metrics associated with CDR: level 4 issues opened vs. Resolved (PDR RID closure Component designs completion measurement/percentages, plan vs. Actual test procedures, plan vs. Actual object-level baseline diagrams completion percentages< plan vs. Actual	

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CDR ASSESSMENT PROCESS	ESDIS ECS CDR Success Criteria	OTHER Criteria Source
SYSTEMS ENGINEERING II-A. Verify Risk Assessment List item *incorporation* compare and trace list to trade studies and decisions	• results of prototypes/trade studies required by CDR • updates SW size estimates • issues/risks/problems (e.g. review of TBDs, RIDs since PDR)	Risk Assessment List 210-CD-001-002, March, 1995 DID 211 - Trade-off Studies *Software Development Plan for the ECS Project, December 1994, HAIS, 308-CD-001-003 (revised 7/95)*
II-B. Verify ESDIS COTR specified Systems Engineering criteria review new SDP, reuse strategy, and test strategy for changes and analyze effects review demonstrated reuse, SDP, and test	• software reuse strategy • changes to testing strategy • changes to SW development/management plan since PDR	*Software Development Plan for the ECS Project, December 1994, HAIS, 308-CD-001-003 (revised 7/95)*
II-C. Verify Multi-track Development Implementat'n verify that HAIS did the 6 basic steps they planned	• changes to SW development/management plan since PDR	*Software Development Plan for the ECS Project, December 1994, HAIS, 308-CD-001-003 (revised 7/95*
II-D. Verify Planned OMT Model Of Evolving Requirements verify that prototype requirements are captured in formal requirements and configuration process and tools,(science requirements*)*	• results of prototypes/trade studies required by CDR	*Software Development Plan for the ECS Project, December 1994, HAIS, 308-CD-001-003 (revised 7/95)* GAO Testimony on EOS, March, 1995 Prototyping and Studies Plan for the ECS Project, May 1994, HAIS

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CDR ASSESSMENT PROCESS	ESDIS ECS CDR Success Criteria	OTHER Criteria Source
PROGRAMMATICS III-A. Verify ECS Model Fidelity get Cost/Performance and User/Production model fidelity assessment through IV&V requirements and model analysis task		Management of Major System Programs and Projects HANDBOOK, NASA NHB 7120.5, Nov. 8, 1995
III-B. Verify technical product schedule meets end-to-end test as scheduled get requirements from IV&V test/ integration, release plan and program requirements; verify dates	• does schedule provide for early/sufficient testing of end-to-end capabilities? • Milestones/schedules to reflect events/critical path • required resources	EOS Ground System, Integration and Test Philosophy, Feb. 1995 *Software Development Plan for the ECS Project, December 1994, HAIS, 308-CD-001-003, revised 7/95*
III-C. Correlate Contractor Software Quality Assurance metrics comparison of HAIS metrics vs IV&V metrics on system release A, CSCI, and critical components	• Metrics associated with CDR: 1. level 4 issues opened vs. Resolved (PDR RID closure status) 2. Component designs completion measurement/percentages, plan vs. Actual 3. test procedures, plan vs. Actual 4. costs selections (numbers of) plan vs actual 5. approved PO's, plan vs actual 6. software developed, planned SLOC vs. Actual SLOC by month 7. object-level baseline diagrams completion percentages< plan vs. Actual 8. scheduled key events (e.g. workshops, prototype/early SW deliveries) completion measurement plan vs. actual	*Software Development Plan for the ECS Project, December 1994, HAIS, 308-CD-001-003, revised 7/95*
III-D. Verify contractor specified Object Transition Plan in place review 10+ HAIS specified steps (including training, mentoring, tool use)	• required resources	*Software Development Plan for the ECS Project, December 1994, HAIS, 308-CD-001-003 (revised 7/95)*

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APPENDIX B: CONTACT LIST

Parag Ambardakar, HAIS Release A Development Manager

Debbie Blake, ESDIS Development Acting Deputy Sci Info Systems Development

Candace Carlisle, SMO Interface Manager

Paul Fingerman, HAIS CDR focal point,

Hal Folts, Distributed systems and Networks Manager

Michael Gayle HAIS Quality Assurance Manager

Theodore Hammer, ESDIS Quality Assurance Manager

Gail McConaughy, NASA SMO System Architect

APPENDIX C: REFERENCED DOCUMENTS

- U.S. General Accounting Office Testimony before Subcommittee on Space and Aeronautics, Committee on Science, House of Representatives, on 3/16/95: Earth Observing System Concentration on Near-term EOSDIS Development May Jeopardize Long-term Success, Jack.L. Brock, Jr.Director Information Resource Management /National Security and Internal Affairs Accounting and Information Management Division
- EOSDIS IV&V Technical Analysis Memorandum (TAM) assessment on external Interface Control Document (ICD) Data Item Descriptor (DID) 209/SE1, (EOSVV-TAM-09-04-04/28/95), EOSDIS IV&V team, April 1995.
- EOSDIS Core System Contract Data Requirements Document, Revision A, 423-41-03, NAS5-6000, Attachment D, June 2, 1994.
- EOS Ground System, Integration and Test Philosophy, white paper, February 1995.
- EOSDIS IV&V Technical Analysis Memorandum (TAM), SDPS Design Evaluation for EOSDIS Core System (ECS) Interim Release 1 (IR-1), EOSVV-TAM-06-001--5/31/95.
- memo Subject: CDR Success Criteria-IAR (WDBN/MSWD), Mel Banks/Code 505
- James Rumbaugh, et al, Object Oriented Modeling and Design, Prentice-Hall International, Inc., c 1991
- Prototyping and Studies Plan for the ECS Project, May 1994, HAIS, CDRL item 052, 194-317-MG1-001
- Software Development Plan for the ECS Project, Dec.1994, HAIS, 308-CD-001-003

  revised July, 1995
- Management of Major System Programs and Projects HANDBOOK, NASA NHB 7120.5, Nov. 8, 1995
- *Defining Architectural Development of EOSDIS to Facilitate Extension to a Wider Data Info System, 194-00131, April, 1994*

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